

Closure Report

File Number : MTR/2019/000502

Project Title : Point and interval estimation of some functionals of the distribution function of identically distributed random variables and their sums with applications.

Principal Investigator : Dr. SANTANU DUTTA
Tezpur University
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Total Released Amount : 3,20,000 (INR)

Start Date of the Project: 19 Mar, 2020

Date of completion: 18 Mar, 2023 (36 months)

Total Expenditure : 2,55,139 (INR)

Santanu Dutta

Closure Details

Key outcomes or achievements

Two research papers published during the tenure of this project are the key outcomes. The first publication supported by the MATRICS research grant is titled "Kernel based estimation of the distribution function for length biased data" published in *Metrika* volume 85, pages, 269–287 (2022). See <https://link.springer.com/article/10.1007/s00184-021-00824-3>. This paper covers one of the major goals of the project proposal, viz. estimating distribution function based on length biased data. The other publication titled "Modeling Long Term Return Distribution and Nonparametric Market Risk Estimation" published online in *Sankhya B* (2023) (See <https://link.springer.com/article/10.1007/s13571-023-00303-x>) covers the other important project objective of estimating distribution function and quantiles of the distribution of sum of strongly mixing stationary random variables and its application in finance, especially in the context of Market Risk estimation (for instance estimation of long term Value at Risk and Median Shortfall of a wide variety of assets)

Detailed research report

The followings are the main achievements in the project (a) Asymptotic bias, variance and limiting distributions of empirical and kernel estimators of the distribution function based on positive length biased data are obtained. (b) For the kernel estimator, the asymptotically optimal bandwidth is calculated and rule of thumb bandwidths are proposed. (c) We prove the strong uniform, and L^2 consistency of the distribution function estimators based on length biased data (d) Monte-Carlo Simulations are used to approximate and compare the exact mean squared errors of the distribution function estimators based on length biased data For different test distributions and sample sizes. (e) A mathematical model for asset loss, where the asset is held over a long time period is proposed. This model is a generalization of the well known random walk model. (f) We prove normal approximation and i.i.d. bootstrap approximation of the long-term loss distribution and its quantiles. 2 New Observatio (g) Applications of our results in finance in the context of estimating risk measures such as the Value-at-Risk(VaR), Median Shortfall(MS) and the Short-Fall distribution of an asset or portfolio over a long time period are discussed. Estimation of long term VaR and MS are challenging problems in finance. We have proposed formulae for estimation of long term VaR and MS which work well on real data. (h) The proposed methodology are demonstrated with real data based on the Nifty 50 index of the national stock exchange in India, , Crude oil and Gold daily closing price. We have estimated 95 percent annual VaR and MS of Nifty 50, Crude oil and Gold, which enable the comparison of risk across these asset classes over an investment horizon of one financial year. Following are the new findings and observations in the project: a) In the presence of length bias in the data, the empirical distribution function is a biased estimator of the distribution function. b) For the kernel estimator of $F(y)$, the asymptotically optimal bandwidth in the presence of length bias is found to be proportional to $(ny)^{-1/3}$. This is a new result as in the absence of length bias, the optimal bandwidth is proportional to $n^{-1/3}$, where n is the sample size and $F(y)$ is distribution function at "y". c) Simulations confirm that if we use bandwidth is proportional to $n^{-1/3}$ for kernel estimation of $F(y)$ for length biased data, then mean squared error of the kernel estimator increases substantially. This reiterates the importance of the above observation (b). d) The asymptotically optimal bandwidth is unknown in practice and rule of thumb bandwidths are proposed for the kernel estimator for length biased data. e) At anypoint below the median, the asymptotic mean squared error of the kernel estimator is smaller than that of the empirical distribution estimator based on length biased data. f) A suitably truncated kernel estimator for positive length biased data is proposed and we prove the strong-uniform, and L^2 consistency of this estimator. g) Simulations reveal the improved performance of the truncated kernel estimator for positive length biased data in estimating tail probabilities based on length biased data. h) In another paper, Dutta and Powdel (2023), we have introduced a mathematical model for asset loss, where the asset is held over a long time period. This model is a generalization of the well known random walk model, in the sense that the summands in the partial sum are stationary strongly mixing type random variables satisfying some dependence assumptions. i) The above mentioned model in (h) provides a mathematical basis for normal approximation and i.i.d. bootstrap approximation of the long-term loss distribution and its quantile. j) Let $X_{(m,t)}$ denote the return in logarithmic scale in $(t, t+m]$. For large m , and under Assumption 1 (stated in Dutta and Powdel (2023)), the distribution of the ratio $(X_{(m,t)} - m\bar{x}_t) / (m\bar{\sigma}_t)$ is well approximated by the standard normal distribution and also by the classical i.i.d. bootstrap method by Efron. k) Following formulae for 100p-percent, m-period VaR and Median Shortfall are obtained $VaR(m,p) = -m\bar{x}_t - \bar{\sigma}_t m^{(-1)}(1-p)$ And $MS(m,p) = -m\bar{x}_t - \bar{\sigma}_t m^{(-1)}(1-0.5(1+p))$ Where $^{(-1)}(p)$ denotes the 100p th percentile of standard normal distribution and \bar{x}_t And $\bar{\sigma}_t$ are mean and standard deviation of 1-period returns l) The corresponding bootstrap estimators m-period VaR and Median Shortfall are obtained by similar formula, only replacing standard normal percentiles by the bootstrap approximation of the corresponding percentiles. m) Closed form formula of conditional long term loss distribution, given that the long term loss exceeds VaR level n) Roy's and Kataoka's safety-first criterion for assets over long term.

Santanu Dutta

Number of students/Researchers trained : 1

Santanu Dutta

List of Publications (only from SCI indexed journals) :

Title of the Paper	List of Authors	Journal Details	Month & Year	Volume	Status	DOI No	Impact Factor
Kernel based estimation of the distribution function for length biased data	Arup Bose and Santanu Dutta	METRIKA (International)	Jan-2022	85 (269-287)	Published	https://doi.org/10.1007/s00184-021-00824-3	

List of Papers Published in Conference Proceedings, Popular Journals :

Title of the Paper	List of Authors	Journal Details	Month & Year	Volume	Status	DOI No	Impact Factor
Modeling Long Term Return Distribution and Nonparametric Market Risk Estimation	SANTANU DUTTA, TUSHAR KANTI POWDEL	SANKHAYA B (International)	Feb-2023		Accepted	http://dx.doi.org/10.1007/s13571-023-00303-x	

List of Patents filed/ to be filed :

Patent Title	Authors	Patent Type	Country/Agency Name	Patent Status	Application/Grant No.
Not Available					

Collaborative visits in India and abroad using MATRICS grant

S.no	Collaborator Details	Work Done
1	<p>Siddhartha Pratim Chakrabarty Indian Institute of Technology Guwahati Department of Mathematics Indian Institute of Technology Guwahati Guwahati-781039, Assam, India Country : India Duration : 14 Mar, 2023 - 14 Mar, 2023</p>	<p>Estimation of Roy and Kataoka's safety-first criterion for long term and delivered one hour duration invited lecture titled "Modeling long term return distribution and market risk estimation". Obtained closed form formulae for Roy and Kataoka's safety-first criterion over a long investment horizon</p>

Any other collaborative work carried out

Collaborator: Professor Arup Bose, Stat-Math Unit, Indian Statistical Unit, Kolkata, India
 Research Output: Paper titled " Kernel based estimation of the distribution function for length biased data"
 Authors : Arup Bose & Santanu Dutta
 Journal: Metrika volume 85, pages269-287 (2022)

Abstract : Empirical and kernel estimators are considered for the distribution of positive length biased data. Their asymptotic bias, variance and limiting distribution are obtained. For the kernel estimator, the asymptotically optimal bandwidth is calculated and rule of thumb bandwidths are proposed. At any point below the median, the asymptotic mean squared error of the kernel estimator is smaller than that of the empirical estimator. A suitably truncated kernel estimator is positive and we prove the strong uniform, and L2 consistency of this estimator. Simulations reveal the improved performance of the truncated kernel estimator in estimating tail probabilities based on length biased data.

Santanu Dutta



**42nd Annual Convention of Indian Society for Probability and Statistics
International Conference on Statistics, Probability,
Data Science and Related Areas (ICSPDS2023)**

Certificate of Paper Presentation

This is to certify that
Dr. Santanu Dutta, Professor, Tezpur University, India
presented a paper entitled
“Modeling long term return distribution and market risk estimation.”

in the
International Conference on Statistics, Probability, Data Science and Related Areas, held during
04th - 06th January 2023, organized jointly by the
Department of Statistics, Cochin University of Science and Technology

&
Indian Society for Probability and Statistics.

Santanu Dutta

Prof. S C Malik
Secretary
ISPS

Prof. N Balakrishna
President
ISPS

Dr. Irshad M R
Secretary
ICSPDS2023

Prof. S M Sunoj
Convener
ICSPDS2023

**RECURRING
GFR 12 – A
[(See Rule 238 (1))]
UTILIZATION CERTIFICATE (UC) FOR THE YEAR 2022-2023
in respect of **RECURRING**
as on **18-March-2023** to be submitted to SERB
UC (Provisional/Audited)**

(To be given separately for each financial year ending on 31st March)

1. Name of the grant receiving Organization: **Tezpur University**
2. Name of Principal Investigator(PI) : **SANTANU DUTTA**
3. SERB Sanction order no. & date : **SERB/F/11096/2019-2020 dated 16 March 2020**
4. Title of the Project : **Point and interval estimation of some functionals of the distribution function of identically distributed random variables and their sums with applications**
5. Name of the SERB Scheme : **MTR – MATRICS**
(Mathematical Research Impact-Centric Support Scheme)
6. Whether recurring or non-recurring grants: **Recurring**
7. Grants position at the beginning of the Financial year (Grants released by SERB)
 - (i) Cash in Hand/Bank /Carry forward from previous financial year : **Rs 172341.00**
 - (ii) Others, If any : **Nil**
 - (iii) Total : **Rs 172341.00**

8. Details of grants received, expenditure incurred and closing balances: (Actuals)

Unspent Balance of Grants received previous years [figure as at Sl.No. 7(iii)]	Interest Earned thereon	Interest deposited back to the SERB	Grants received during the year			Total Available funds (1+2-3+4)	Expenditure incurred	Closing Balances (5-6)	Remark
			Sanction No. (i)	Date (ii)	Amount (iii)				
1	2	3	4			5	6	7	8
172341/-	2341	NIL				1,74,682/-	106604/-	68,078/-	Project to be closed And Rs 68,078/- to be refunded

9. Component wise utilization of grants

Grants-in-aid- General	Total	Remark
Research Grant	Rs 106604 /-	
Overhead	NIL	
GRAND TOTAL	Rs 106604/-	

10. Details of grants position at the end of the year

- (i) Cash in Hand/Bank : **Rs 68,078/-**
- (ii) Refunds to SERB, If any : **NIL**
- (iii) Balance (To be refunded): : **Rs 68,078/-**

 Signature Name: SANTANU DUTTA Principal Investigator(PI)	 Signature with Seal Name: Finance Officer	 Signature with Seal Name: Head of Organisation
	<i>Finance Officer</i> <i>Tezpur University</i>	<i>Registrar</i> <i>Tezpur University</i>

GFR 12 – A
[(See Rule 238 (1))]
UTILIZATION CERTIFICATE (UC) FOR THE YEAR 2022-2023
in respect of RECURRING
as on 18-March-2023 to be submitted to SERB
Is the UC (Provisional/Audited)
(To be given separately for each financial year ending on 31st March)

Certified that I have satisfied that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose for which it was sanctioned:




- (i) The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the Act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.
- (ii) There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.
- (iii) To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.
- (iv) The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.
- (v) The benefits were extended to the intended beneficiaries and only such areas/districts were covered where the scheme was intended to operate.
- (vi) The expenditure on various components of the scheme was in the proportions authorized as per the scheme guidelines and terms and conditions of the grants-in-aid.
- (vii) It has been ensured that the physical and financial performance under
(CRG/NPDF/ECR.....etc.) (Name of the scheme has been according to the requirements, as prescribed in the guidelines issued by Govt. of India and the performance/targets achieved statement for the year to which the utilization of the fund resulted in outcomes given at Annexure

I duly enclosed.

- (viii) The utilization of the fund resulted in outcomes given at Annexure – II duly enclosed (to be formulated by the Ministry/Department concerned as per their requirements/specifications.)
- (ix) Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure –II (to be formulated by the Ministry/Department concerned as per their requirements/specifications).

Date: 26/04/2023

Place: TEZPUR UNIVERSITY

 Signature Name: SANTANU DUTTA Principal Investigator(PI)	 Signature with Seal Name: Finance Officer	 Signature with Seal Name: Head of Organisation
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(Strike out inapplicable terms)

Finance Officer
Tezpur University

Registrar
Tezpur University

REQUEST FOR ANNUAL INSTALMENT WITH UP-TO-DATE STATEMENT OF EXPENDITURE SOE

- 1 Sanction Order No and date SERB/F/11096/2019-2020 dated 16 March. 2020
- 2 Total Project Cost: Rs. 6,60,000/-
- 3 Revised Project Cost:
(if applicable)
- 4 Date of Commencement 19/03/2020
- 5 Statement of Expenditure:
(month wise expenditure incurred during current financial year)

Month & year	Expenditure incurred/ committed
MAY 2022	Rs 9240/- (incurred)
AUGUST 2022	Rs 27,500/- (incurred)
November 2022	Rs 12,500/- (incurred)
February 2023	Rs 29,967/- (incurred)
March 2023	Rs 27,397/- (incurred)

Grant received in each year:

S.No. Particulars	Amount
a. 1st Year	Rs. 2,20,000/-
b. 2 nd Year	Rs. 1,00,000/-
c. 3rd Year	Nil
d. Interest earned	Rs 3,362/- + Rs. 2514/- + Rs 2341/- = Rs 8,217/-
Total (a+b+c+d)	Rs. 3,28,217/-

Statement of Expenditure

(to be submitted financial year wise)

S.NO.	Sanctioned Heads	Total Funds Allocated (indicate sanctioned or revised)	Expenditure Incurred in Rs				Total Expenditure Rs	Balance as on 31 st December 2022	Requirement of funds upto 31 st March FY2023	Remarks (if any)
			1 st Year DOC* to 31 st March 2020	2 nd Year 1 st April 2020 to 31 st March 2021	3 rd year 1 st April 2021 to 31 st March 2022	4 th year 1 st April 2022 To 18 th March: 2023				
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(ix)=(iii-viii)	Nil	Project to be closed And Rs68,078/- To be refunded	
1	Research Grant	Rs 300,000/-	Nil	Rs 73,010/-	Rs 55,525/-	Rs 106604 /-	Rs 64,861/-			
2	Overhead Expenses	Rs 20,000/-	Nil	Rs 12,500/-	Rs 12,500/-	Nil	-Rs 5000/-			
3	Interest Earned	Rs 3,362/-+Rs. 2514/- +Rs 2341 - =Rs8,217/-	Nil				Rs 8,217/-			
	Total	Rs 3,28,217/-	Nil	Rs 85,510/-	Rs 68,025/-	Rs106604 /-	Rs 260,139 /-	Rs 68,078 /-		

Amount spent on International travel: Nil

SANTANU DUTTA

Santanu Dutta
Name and Signature of PI

Seal and Signature of Registrar/Head of Institute

Date: 26/04/2023

Date:

Santanu Dutta
Registrar

Date:

Santanu Dutta
Signature of accounts officer

Date:

Registrar
Teespur UniversityFinance Officer
Teespur University

* DOC-Date of Commencement (dd-mm-yyyy): 19-03-2020